Doug Mahone
Pacific Gas & Electric Co
Heschong Mahone Group

Lighting Controls Under Skylights

California Building Energy Efficiency Standards
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Purpose

This document presents information necessary to complete a preliminary evaluation of modifying the lighting control requirements under skylights as currently contained in the 2005 Building Energy Efficiency Standards. Information provided through this template will be used to identify possible changes to the Standards to be released for comment in July 2002 and adopted in July 2003.

Description

The initiative will address three aspects of the lighting controls requirements as they apply to skylights:

- Modifying the description of the daylit zone under skylights. The current definition allows all electric lighting within one ceiling height of the skylight "footprint" to be considered part of the skylit zone. This defines too large of an area to be on a single control or alternatively allows the skylight spacing to be too large to provide uniform illumination. The current definition allows what the lighting designers call a "spacing criterion" of at least 2.0; in contrast most luminaires have a spacing criterion of 1.5 or less.
- Adding a Mandatory requirement for automatic controls to control fixtures in the daylit area. An exemption to this requirement will be allowed for buildings, which have a combined area of skylit zones less than xxx ^{ft2} (minimum area will be defined during cost-effectiveness determinations). Timeclocks would be an acceptable automatic control in addition to photocontrols. Photocontrols would have the added benefit of a Power Adjustment Factor (see below).
- Modification of the Power Adjustment Factors (PAF's in Table 1-L) to give more credit to automatic stepped daylighting controls under skylights. Also more credit should be given to skylighting systems that use diffusing skylights are elements as compared to clear skylights.

Benefits

Skylighting saves energy and peak demand if the skylighting system is sized correctly and electric lighting is turned off when there is sufficient daylight available. The mandatory controls aspect of this measure can save up to 80% of peak lighting demand and up to 50% of lighting energy in the skylit zone. The redefinition of the skylit zone will encourage good skylighting design so that greater uniformity is achieved. This improves the visual quality and potentially improves the persistence of the controls measures.

Environmental Impact

This measure would reduce 50% of lighting energy in the skylit zone and thus would reduce environmental impacts from energy consumption. Negligible adverse impacts are expected from the manufacture of electronic components used to control lighting circuits.

Type of Change

This measure would effect the nonresidential standards and the compliance manual.

This measure does not impact the performance method and thus does not affect the computer programs or the ACM Manual.

Measure Availability and Cost

Controls required are currently commercially available at relatively low cost. The lowest cost (but also lowest savings) solution would use time clocks and relays, which are ubitiquous in the building controls market. Cost-effectiveness will be based on the more expensive photocontrol system.

Useful Life, Persistence and Maintenance

The power savings and benefits of this measure are well-established and have been promoted by the Advanced Lighting Guidelines since 1990. The largest unknown is the calibration and performance of automatic daylighting controls. Our interviews with market players have recorded mixed results from systems that have no problems at all to those, which have never worked from day of installation.

To this end we have focussed on daylighting controls for the electric lighting under skylights because these controls are more robust and less likely to fail. Simple open loop controls in these spaces perform much in the same way that huge savings in street lighting have been realized using photocontrols. For those designers who resist using a relatively unknown technology, the requirements allow the use of the very familiar timeclock to control lights in the skylit zone.

Performance Verification

Photocell controls require calibration to deliver savings. These controls must be enabled before final inspection so the inspector can see that lights are responding to available daylight.

Cost Effectiveness

This requirement will be shown to be cost-effective in subsequent tasks. This task will characterize the costs of controls in various configurations. The installed costs of these controls contain fixed and system size dependent components. The cost and energy savings of controls for lighting in the skylit zone are proportional to the area being controlled. The minimum area that mandatory controls are required will be adjusted so that the measure is clearly cost-effective.

Analysis Tools

The performance method for nonresidential buildings (DOE-2 engine in EnergyPro) contains a daylighting modeling capability. To evaluate the appropriate definition of the skylit zone, we will make use of skylight photometric files that are being created through PIER (Public Interest Energy Research) testing of skylights and light wells. These files will be used in conjunction with standard lighting design software (in our case we are using LumenMicro) to evaluate the uniformity of light under skylights at different spacing dimensions.

Relationship to Other Measures

A similar measure is proposed for the larger topic of requiring automatic controls for all large daylit zones (from either windows or skylights). This measure would need to be coordinated with the other measure so that the requirements are easy to understand and straightforward to apply.

Bibliography and Other Research

Skylighting Guidelines, available at www.energydesignresources.com
Advanced Lighting Guidelines, available at www.newbuildings.org